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APPLICATION

FOR

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TO THE COMMISSIONER FOR PATENTS:

BE IT KNOWN, that we,

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Roderick T. Hinman of Natick, Massachusetts,
Al-Thaddeus Avestruz of Arlington, Massachusetts,
E. C. Lupton of Charlestown, Massachusetts,
Deron Jackson of San Jose, California, and
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have invented certain new and useful improvements in

HYBRID OPTICAL COMMUNICATION NETWORKS, of which the following is a specification:

HYBRID OPTICAL COMMUNICATION NETWORKS

This application is a continuation-in-part of and claims priority to U.S. Patent Application No. 10/161,458 filed on May 31, 2002, which is a continuation of and claims priority to U.S. Patent Application No. 09/291,709, filed April 14, 1999, which claims priority to U.S. Provisional Patent Applications 60/081,866 dated 4/15/98, 60/108,287 dated 11/13/98 and 60/115,374 dated 1/11/99, the contents of all of which are hereby incorporated by reference in their entirety. It is also a continuation-in-part of and claims priority to U.S. Patent Application 10/201,378 filed on July 23, 2002 which claims priority to U.S. Provisional Patent Application 60/308,486 filed July 25, 2001, U.S. Provisional Patent Application 60/311,037 filed August 9, 2001, U.S. Provisional Patent Application 60/326,277, filed October 1, 2001, U.S. Provisional Patent Application 60/338,912 filed November 26, 2001, U.S. Provisional Patent Application 60/337,491 filed November 26, 2001, U.S. Provisional Patent Application 60/341,191 filed December 7, 2001, U.S. Provisional Patent Application 60/353,253 filed February 1, 2002 and U.S. Provisional Patent Application 60/367,393 filed March 25, 2002, which is a continuation of and claims priority to application 09/770, 806 filed Jan 26, 2001 now U.S. Patent 6.426.599 issued July 30, 2002 which claims priority to and incorporates by reference U.S. Provisional Patent Application 60/191,725 filed March 24, 2000, which is a continuation of and claims priority to application 09/291,706 filed April 14, 1999 now U.S. Patent 6,198,230 issued March 6, 2001 which claims priority to U.S. Provisional Patent Applications 60/081,866 dated 4/15/98, 60/108,287 dated 11/13/98 and 60/115,374 dated 1/11/99, the contents of all of which are hereby incorporated herein by reference in their entirety and which incorporated by reference application 09/292,126 filed April 14, 1999 now U.S. Patent 6,504,633 issued January 7,2003 which claims priority to U.S. Provisional Patent Applications 60/081,866 dated 4/15/98, 60/108,287 dated 11/13/98 and 60/115,374 dated 1/11/99. It claims priority to U.S. Provisional Patent Applications 60/402,434 filed August 9, 2002, 60/416,357 filed October 4, 2002, 60/450,072 filed Feb 25, 2003 and Express Mail Filing Receipt ET999298105US filed

June 6, 2003. All patents and patent applications mentioned above are incorporated in their entirety herein by reference. This application hereby also incorporates by reference in their entirety the contents of the following patent, patent applications and other documents and all the references included or mentioned in this application or in each of these references: U.S. Patent No. 6,198,230, "Dual Use Electronic Transceivers for Wireless Data Networks" issued March 6, 2001; U.S. Patent 6,400,482, "Communication Systems", issued June 4, 2002; U.S. Patent 6,426,599, Dual Use Electronic Transceivers for Wireless Data Networks, issued July 30, 2002; U.S. Patent 6,504,633, "Analog and Digital Receivers for Dual Use Wireless Data Networks, issued Jan 7, 2003; U.S. Patent Applications Nos. 09/291,709 "Communication Systems" filed April 14, 1999, 09/292,126 "Analog and Digital Electronic Transceivers for Dual-Use Wireless Data Networks" filed April 14, 1999, and 09/770,806 "Dual Use Electronic Transceivers for Wireless Data Networks" filed January 26, 2001; U.S. Provisional Patent Applications Nos. 60/081,866 "Fluorescent Lamp Digital Transceiver" filed April 15, 1998, 60/108,287 "Visible Lighting Communication System" filed November 13, 1998, 60/115,374 "Visible Lighting Communication System II" filed January 11, 1999, 60/191,725 "Communication Networks" filed March 24, 2000, 60/308,486 "Hybrid Wireless Network" filed July 25, 2001, 60/311,037 "Multi-Element Assistive Network" filed August 9, 2001, 60/326,277 "Dual Use Lighting for Assistive Communications" filed October 1, 2001, 60/338,912 "Modulated Lighting" filed November 26, 2001, 60/337,491 "Spread Spectrum Arc Lighting Communication" filed November 26, 2001, 60/341,191 "Vehicle Guidance" filed December 7, 2001, 60/353,253 "Optical Communications" filed February 1, 2002, 60/367,393, "Incandescent Light Optical Communication" filed March 25, 2002, 60/402,434, "Communication via Modulated Illumination", filed August 9, 2002, 60/416,357, "Lighting Communication Point:, filed October 4, 2002, 60/450,072 , "Context Aware Security through Illumination", filed February 25, 2003 and Express Mail Filing Receipt ET999298105US, "Context Aware Assistive Network", Filed June 6, 2003; PCT Applications Nos. WO00/30415 "Communications Systems" published May 25, 2000, WO99/53633 "Analog and Digital

Electronic Transceivers for Dual-Use Wireless Data Networks" published October 21, 1999, and WO99/53732 "Dual-Use Electronic Transceiver set for Wireless Data Networks" published October 21, 1999; Leeb, S.B. *et al.*, "Assistive Communication Systems for Disabled Individuals using Visible Lighting," *15th International Conference on Technology and the Disabled*, March 24, 2000; and Jackson, Deron K. *et al.* "Fiat Lux, A Fluorescent Lamp Transceiver", *IEEE Transactions on Industrial Applications*, vol. 34, No. 3, pp 625-630, May/Jun 1998. D.T. Burke, S.B. Leeb, R. T. Hinman, E. C. Lupton, J. Burke, J. C. Schneider, B. Ahangar, K. Simpson, E. A. K Mayer, "Using Talking Lights to Assist Brain-Injured Patients with Daily Inpatient Therapeutic Schedule", J. Head Injury Trauma, , **16**, 3, 284-291(2001).; R.T. Hinman, S.B. Leeb., A. Avestruz, E.C. Lupton, B.L. Bentsen, R. Easton, "Dual Use Lighting for Assistive Communications",2002 NSF Design, Service and Manufacturing Grantees and Research Conference, January 2002 (on CD).; A. Avestruz, E. C. Lupton, R. T. Hinman, S.B. Leeb and A. Culkin, "Smart Markers for In-Depth Battlefield Information: Optical and Hybrid Communication", 23rd Army Science Conference, Orlando FL, Dec. 2002.; A. Avestruz, E. C. Lupton, R. T. Hinman, S. B. Leeb and G. Livshin, "Smart Markers for In-depth and Perimeter Security Information using Optical and Hybrid Communications", IEEE Conference on Technologies for Homeland Security, Spring 2003.; G. Livshin, A. Avestruz, R. T. Hinman, S. B. Leeb and E. C. Lupton, "Context Aware Security Based On Illumination (CASI)", IEEE Conference on Technologies for Homeland Security, Spring 2003.

Background of the Invention

A communication network is a means for conveying information from one place to another. The information can be in audio, digital data, video, text, graphics, data, sign language or other forms. The network can be a wide area network such as an intranet in an office, store or factory. Establishing and maintaining communication networks is one of the oldest known activities of mankind ranging from the shouting and drum signals of prehistory through written messages, signal flags, signal fires, smoke signals, signal

mirrors, heliographs, signal lanterns, telegraphs, radios, telephones, televisions, microwave signals, linked computers and the internet. Improving communication networks will continue to be a major technical focus in the future.

The ideal communication network would be non-intrusive, inexpensive, extremely large information carrying capability (wide bandwidth), instantaneous and suitable for use with a broad variety of transmission and reception technologies.

There have been a few reports of the use of visible lighting as a carrier in electronic communication networks. The earliest reference to using lighting to send electronic information as well as to provide illumination appears to be Dachs (U.S. Patent 3,900,404) disclosing an analog amplitude-modulation (AM) scheme to modulate the arc current in a fluorescent lamp, the "carrier'' signal, with an audio information signal. King, Zawiski and Yokoun (U.S. Patent 5,550,434) disclosed an updated electronic circuit that also provides for AM modulation of the arc current with an analog signal. Smith (U.S. Patent 5,657,145) teaches a method for encoding low-bandwidth digital information into the lamp light using a pulsed AM technique. The encoding technique involves chopping 100 microsecond slices of current out of the arc waveform. Nakada (Japanese Patent application 60-32443, Feb 19, 1985.)reports a FM modulation and a frequency shift keying (FSK) scheme to transmit digital data using visible lighting. Gray (U.S. Patent 5,635,915 June 3, 1997 and PCT WO90/13067, Oct 11, 1991.) has reported a product pricing system for supermarket shelf labels where a signal is sent from visible lighting to individual product price labels on shelves to cause the listed prices to change when desired.

Other communication schemes have been proposed that do not use the lamp light as the carrier, but instead use the lamp fixture as an antenna for transmitting conventional radio wave or microwave signals. In Uehara and Kagoshima (U.S. Patent 5,424,859), for example, the inventors disclose techniques for mounting a microwave antenna on the glass surface of fluorescent and incandescent lamps. Buffaloe, Jackson, Leeb, Schlecht, and Leeb, ("Fiat Lux: A Fluorescent Lamp Transceiver,'' *Applied Power Electronics Conference*, Atlanta, Georgia, 1997) first outlined the possibility of using pulse-code

modulation to transmit data with a fluorescent lamp. In the latter reference, a three-level code shifts the arc frequency to one of three possibilities every Tsw= 2 milliseconds. The result is a steady light output, on average, with no perceptible flicker. A one or a zero bit does not correspond to a particular arc frequency, but rather, to a three level pattern in arc frequency. A logic zero bit is transmitted by varying the arc frequency first to 40 kHz, then to 38 kHz, and finally to 36 kHz. A logic one bit is transmitted by the arc frequency pattern beginning with 38 kHz, followed by 40 kHz, and ending with 36 kHz. A unique start bit, used to demarcate the beginning of a transmitted byte, is represented by a sequence in the arc frequency beginning with 36 kHz, followed by 38 kHz, and ending with 36 kHz.

In our previously filed patent applications serial number 09/291,706 filed April 14, 1999 and entitled "Dual-Use Electronic Transceiver Set for Wireless Data Networks" and application serial number 09/292,126 filed April 14, 1999 entitled "Analog and Digital Electronic Receivers for Dual-Use Wireless Data Networks", we have disclosed visible light communications networks for analog and digital data based on frequency modulation of light. The modulation techniques include direct FM, 2 level half weight bit coding and other orthogonal bit coding schemes.

The visible light case mentioned above is a specific case of our invention which, stated generally, involves simultaneous intentional dual use of transmitted electromagnetic radiation for two completely different useful purposes.

Summary of the Invention

With the new technology disclosed in our previously filed applications, the recent advances in computer technology and other improvements in electronics, a number of applications and uses are now enabled. These applications are most preferentially executed using our new technology. However, in some cases, they may be executed using some of the other technologies known in the prior art.

Our communication network contains the following elements in series:

a) A source of the information which will be transmitted

b) A transmitter, which includes lamp and a means for controlling the modulation of the lamp to cause the lamp to carry a signal

c) A medium through which the light passes from the transmitter to the receiver

d) A receiver for receiving and demodulating the light in order to obtain the information

e) A user for the information. This user can be a device, like a computer or a compact disk player, or it can be a person.

Our invention embodies a number of uses and purposes for the light based communication network. One purpose is to process the signal from the light by the receiver to control the selection of information from a computer memory , CD or other storage device for large scale storage of data, greatly increasing the effective bandwidth of the information which can be transmitted. Another purpose is to provide data to the user from the receiver from both a large scale data storage device, like a computer memory, compact disk or other such device, and from the information transmitted by the light, with segments of data from the sources interspersed in presentation to the user. Another purpose is to provide data from a device source , like a computer chip, a tape cassette a compact disk or other such device, to the transmitter. Another purpose is to repeat continually the data from the device source, providing a continuous signal of finite period to the user. Another purpose is to use two or more transmitting lights, each transmitting its own signal at the same frequency to provide spatial resolution of signal so that the receiver will receive and provide to the user information from only one of the lights at any time and the receiver may shift its reception from one light to another. Another purpose is to transmit two or more different signals simultaneously at different frequencies from one light in such a manner that two or more receivers can each pick up the different signals. Another purpose is to transmit two or more different signals containing the same information in two or more different languages or codes so that by selecting the proper frequency, the user can select information in the language or code they deem most suitable. Another purpose is to encrypt the information prior to transmission and decrypted it subsequent to receipt. Another purpose is to use the

lighting of an individual exhibit to provide to the user a description of some aspect of the exhibit. Another purpose is to transmit information over the network used to provide assistance to individuals who are visually impaired. Another purpose is to transmit information transmitted over the network to provide assistance to individuals who are hearing impaired. Another purpose is to transmit over the network to provide assistance to individuals who are mentally impaired. Another purpose is to transmit the information transmitted over the network for processing by the user and subsequent sending out of a responding signal by the user using some means. Another purpose is to use the network to provide information to a receiver and user which are moving. Another purpose is to use the network to provide information inside an aircraft, boat, submarine, bus, auto, train or other vehicle. Another purpose is to use the network to provide guidance information to a receiver and user which are moving. Another purpose is to use the network to provide safety or warning information. Another purpose is to use create a network where the same information is being provided by a plurality of different lights. Another purpose is to use the network to provide paging information to the user. Another purpose is to provide information in classrooms and other meeting rooms. Another purpose is to create a repeater network where the modulated signal initiated by one light will be received by an adjoining light, that light started modulating, etc. until all lighting in a network is being modulated and carrying the signal. Another purpose is to create a network in which the electromagnetic radiation which is modulated is infrared radiation. Another purpose is to create a network in which the electromagnetic radiation which is modulated is ultraviolet radiation. Another purpose is to create a network in which the electromagnetic radiation which is modulated is radio frequency radiation. Another purpose is to create a network in which the electromagnetic radiation which is modulated is microwave radiation. Another purpose is to create a network in which the electromagnetic radiation which is modulated is X-ray radiation. Another purpose is to create a network to transmit compressed data.

In another aspect, the invention is a method of locating a structure by providing a lighting infrastructure, each optically transmitting a respective relative position of that

transmitter with respect to a fixed position, detecting the respective relative position of at least one of the transmitters with an optical receiver and determining a relative position of the receiver from the detected relative position. In Lupton, *et.* al. Communication Systems, U.S. Patent 6,400,482, dated June 4, 2002, Filed April 14, 1999 (Lupton 482) which is included in its entirety in this application by reference and also which is included in its entirety by reference in and to which priority is claimed by Lupton, *et.* al.-"Communication System" U.S. Patent application 10/161,458, Filed May 31, 2002 (Lupton 458) which is included in its entirety by reference in and to which priority is claimed in this application and also in George B. Hovorka, Steven B. Leeb, Elmer C. Lupton and Deron Jackson, "Visible Lighting Communication System", U.S. Provisional Patent Application 60/108,287, Filed November 13, 1998 (Hovorka 287) to which priority is claimed in Lupton 482 and by Hovorka 633 and which is included in this application in its entirety by reference, (text) and also in Steven B. Leeb, Elmer C. Lupton , Deron Jackson, George Hovorka and Billie L. Bentzen, "Optical Communication", U.S. Provisional Patent Application 60/353,253, Filed February 1, 2002 (Leeb 253), to which priority is claimed by Lupton 482 and which is included in its entirety by reference in this application, (text), we disclose a system with one or more transmitters, each providing light suitable for illumination and including means for modulating the light with an information signal, a medium such as a fluid through which the light passes, and one or more receivers for receiving the light and demodulating the signal to obtain the information. The PCT application corresponding to Lupton 482 is WO00/30415, published May 25, 2000 which is included herein in its entirety by reference. (Lupton 415) The information may provide directional guidance. (Lupton 482, Abstract). Also Lupton 482, Fig 1 and Lupton 482, col 4, line 35 through col 3, line 4 also Hovorka 482 text and figures and Leeb 253 text and figures). A purpose is to provide spatial resolution of signal and so provide spatial information to the user (Lupton 482, col 2, line 65 through col 3, line 3 also Hovorka 287 text and figures and Leeb 253 text and figures). We teach that the optical transmission can be visible (Lupton 482, col 2, line 16), infrared (Lupton 482, col 3, line 43-44) and ultraviolet (Lupton 482, col

3,-line 45-46 also Hovorka 287 text and Leeb 253 text). We teach that position can be determined in two dimensions (Lupton 482, figure 1 also Hovorka 287 text and Leeb 253 text).

In Hovorka, et. al., Analog and Digital Receivers for Dual Use Wireless Data Networks, U.S. Patent 6,504,633, dated Jan 7, 2003, filed April 14, 1999 (Hovorka 633) which is included in its entirety in this application by reference and also which is included in its entirety by reference in and to which priority is claimed by Lupton 458 which is included in its entirety by reference in and to which priority is claimed in this application, we teach determining the relative position of the receiver by comparing the received signal strength and changes in received signal strength as the receiver moves with the transmitted signal strength from at least one of the transmitters (Hovorka 633, col 3 lines 28-37 also col 7, line 56 col 8 line 45). The PCT application corresponding to Hovorka 633 is WO99/53633 published October 21, 1999 which is incorporated herein in its entirety by reference (Hovorka 3633) Using the two dimensional determination of position of Lupton 482, Hovorka 287 and Leeb 253 and the relative position measurement of Hovorka 633 to determine altitude, one of ordinary skill in the art will know how to determine position in three dimensions. (see also R. Azuma "Tracking Requirements for Augmented Reality" Communications of the ACM, July 1995 p 50-51, (Azuma 95), T. Starner, D. Kirsch and S. Assefa, "The Locust Swarm: An environmentally-powered, networkless location and messaging system", Proceedings of the 1st International Symposium on Wearable Computers, Oct 1997, pp169-170 (Starner 97), F. Angrilli, S. Bastianello and R. DeForno, "Calibration of Stereo Vision Systems by Neural Networks", IMTC-96, Conference Proceedings, "Quality Measurements" The Indispensable Bridge between Theory and Reality", IEEE Vol 2 4-6 June 1996 (Angrilli 96), W. Lutz, G. Holzmuller, G. Steinwender and E.S. Hochmair "Fast measuring of solid angles by means of CCD line scan cameras with analytically rectified optics", Engineering in Medicine and Biology Society, 1994. Engineering Advances: New Opportunities for Biomedical Engineers. Proceedings of the 16th Annual International Conference of the IEEE, 3-6 Nov. 1994 (Lutz 94), G.V. Puskorius and L.A. Feldkamp

"Camera Calibration Methodlolgy Based on a Linear Perspective Transformation Error Model, Proceedings 1988 IEEE International Conference on Robotics and Automation April 24-29, 1988 pages 1858-1860 vol 3 (Puskorius 88), G.D. Wilkins, "Holographic Optical Elements and Charge Coupled Device Technology at Work in Laser Communications Acquisition and Tracking Systems" Proceedings of the IEEE 1992 National Conference on Aerospace and Electronics, NAECON 1992, May 18-22, 1992 (Wilkins 92) all of which are included in this application in their entirety by reference as illustrative of the art.) Hovorka 633 and Lupton 482 are each included in the other in their entirety by reference. See also Hovorka 287. We teach synchronization of the signal from the transmitters (Lupton 482, col 3, lines 38-42 also Hovorka 287 text) to which priority is claimed by Hovorka 633 and Lupton 482 and which is included herein in its entirety by reference, text, also Al-Thaddeus Avestruz, Roderick T. Hinman, Steven B. Leeb and Elmer C. Lupton, U.S. Provisional Patent Application 60/308,486 filed 7/25/01 (Avestruz 486) which is included herein in its entirety by reference and which is included in its entirety by reference and to which priority is claimed by Lupton 458 and by Steven B. Leeb, Deron K. Jackson, Elmer C. Lupton and George B Hovorka, "Non-Flicker Illumination Based Communication', U.S. Patent Application 10/201,378, Filed July 23, 2002 (Leeb 378) which is incorporated herein in its entirety by reference. .) A person of ordinary skill in the art would know how to synchronize transmitters. See, for example G. Kortuem, Z Segali, and M. Bauer, "Context-Aware, Adaptive Wearable Computers as Remote Interfaces to 'Intelligent' Environments", Second International Symposium on Wearable Computers, Oct 20, 1998 58-65 (Kortuem 98) as illustrative of the art.

In another aspect, we disclose that the receiver can contain a transmitter and transmit information to a central location including transmitting the relative position of the detected transmitters to a central location and determining the receiver's position with respect to the central location. (Lupton 482, Fig. 1., also Lupton 482 (col 6, lines 54-63). Once location is identified and the receiver contains a transmitter, one of ordinary skill in the art would know how to transmit relative position to the central location and determine

the receiver's position with respect to the central location. See, for example, P. J. Brown, J. D. Bovey and X Chen, "Context-Aware Applications: From the Laboratory to the Marketplace", IEEE Personal Communications October 1997, pp 58-64 (Brown 97), B. N. Schilit and M. M. Theimer, "Disseminating Active Map Information to Mobile Hosts" IEEE Network 1994 (Schilit,Theimer 94), G. J. Nelson "User Interaction with Machines on the Move: Location Aware Computing". Proceedings of the Fourth Workshop on Enabling Technologies: Infrastructure for Collaborative Enterprises, April 20-22, 1995 (Nelson 95) all of which are included in this application in their entirety by reference as illustrative of the art.)In yet another aspect, the invention is a method of determining a location at a structure, which comprises providing a lighting infrastructure having transmitters each optically transmitting a respective address; providing a list structure associating each address with a relative position of a respective one of the transmitters with respect to a fixed position; detecting at least one of the transmitters with an optical receiver; determining a position of the optical receiver relative to at least one of the detected transmitters; determining a relative position of at least one of the detected transmitters from the list structure; and determining a relative position of the receiver from the relative position of at least one of the detected transmitters. (Lupton 482, Figure 1, also Lupton 482 col. 6, lines 16-30 and lines 42-53.) We teach further performing the step of determining a relative position of at least one of the detected transmitters by determining an identity of at least one of the detected transmitters; and selecting a corresponding relative position from the list structure (Lupton 482 Fig 1, also Lupton 482 col 6, lines 16-30 and Lines 42-53). We teach further modulating the optical transmission of the respective address in emitted light with the transmitters and performing the step of determining the relative position of at least one of the detected transmitters by demodulating the respective address from the emitted light with the receiver (Lupton 482 Fig 1, also Lupton 482 col 6, lines 16-30 and lines 42-53.) We disclose further modulating the optical transmission of the respective address in emitted light with the transmitters and performing the step of determining the identity by demodulating the respective address from the emitted light with the receiver (Lupton 482

Fig 1, also Lupton 482 col 6, lines 16-30 and Lines 42-53) With this system, we teach optically transmitting a respective unique address with each of the transmitters (Lupton 482 Fig 1, also Lupton 482, col 6, lines 17-18). We teach that the list structure can be part of the receiver (Lupton 482 Fig 1, also Lupton 482 col 6, lines 16-30 and lines 42-53.) We teach that the list structure can be external to the receiver and can be accessed with the receiver through a transmission link. (Lupton 482, Fig 1, also col 6, line 6 col 7 line 36) A person of ordinary skill in the art would consider and would know how to make the list structure external to the receiver and accessing it with the receiver through a transmission link. See, for example, J. Bacon, J. Bates and D. Halls, "Location-Oriented Multimedia", IEEE Personal Communication, October 1997 pages 48-57 (Bacon 97), H. Maass "Open Mobility Management Platform with Directory-Based Architecture and Signalling Protocols, Open Architectures and Network Programming, IEEE April 3-4, 1998 (Maass 98) which are incorporated in this application in its entirety by reference, Brown '97, Schilit, Theimer 94, Kortuem '98 as illustrative of the art. The method can comprise providing a link structure as part of a central computer system and providing the accessing step by accessing the list structure with the receiver through an RF link, an optical link, the lighting infrastructure (Lupton 482, col 7, lines 25-36) ,a local area network (Avestruz 486 text and figures) and a spacecraft (Hovorka 287 text). A spacecraft is a type of satellite. A person of ordinary skill in the art will know how to access the list structure with the receiver using other communication methods including a modem, an acoustic link, an Internet connection, or a direct cellular link See also references listed elsewhere in this application on the art. The method can further comprise updating the list structure to include information regarding additional transmitters added to the infrastructure, to modify information regarding existing transmitters moved to a new position and to delete information regarding transmitters removed from the infrastructure (Lupton 482 Fig 1 also col 1, lines 14-16 and col 6, line 6 - col 7 line 36 also Leeb 230 Col 11, lines 47-48.) An individual of ordinary skill in the art would know how to update the list structure, modify information on additional transmitters and delete information regarding transmitters. See,

for example, B. Schilit, N. Adams and R. Want, "Context Aware Computing Applications" Proceedings of the Workshop on Mobile Computing Systems and Applications, Dec 8-9, 1994 (Schilit, Adams 94) as illustrative of the art. The method also includes the step of determining a relative position of at least one of the detected transmitters by performing a list structure lookup with a processor of the receiver (Lupton 482 Fig 1 also col 1, lines 14-16 and col 6, line-6 - col 7 line 36.) The method further comprises performing the two steps of determining a relative position by: forwarding the position of the receiver relative to the detected transmitters to a central station containing the list structure, determining a relative position of at least one of the detected transmitters from the list structure stored in the central station; and determining a relative position of the receiver from the relative position of at least one of the detected transmitters with the central station. (Lupton 482 Fig 1 also col 1, lines 14-16 and col 6, line 6 - col 7 line 36.) The method further comprises transmitting the relative position of the receiver from the central station to the receiver. (Lupton 482 Fig 1 also col 1, lines 14-16 and col 6, line 6 - col 7 line 36.) An individual of ordinary skill in the art would know how to transmit the relative position of the receiver from the central station to the receiver. See, for example, Bacon 97, Maass 98, Brown '97, Schilit, Theimer 94, Kortuem '98 as illustrative of the art.

In yet another aspect, the invention is a method of determining a location at a structure comprising providing a lighting infrastructure at a structure, the infrastructure having lights and transmitters connected through the lights for optically transmitting a respective relative position of that transmitter with respect to a fixed position through emitted light; detecting the respective relative position of at least one of the transmitters with an optical receiver; and determining a relative position of the receiver from the detected relative position by determining at least a two-dimensional position of the receiver relative to at least one of the detected transmitters (Lupton 482 Figure 1, also Lupton 482, col 2, line 65 through-col 3, line 3 and Hovorka 633 col 3 lines 28-37 also col 7, line 56 - col 8 line 45).

In still another aspect, the invention is a method of determining a location at a structure comprising providing a lighting infrastructure having transmitters each transmitting a respective address, providing a list structure associating each address with GPS and an absolute terrestrial position of a respective one of the transmitters; detecting at least one of the transmitters with an optical receiver; determining a position of the receiver relative to at least one of the detected transmitters; determining an absolute terrestrial position of at least one of the detected transmitters from the list structure; and determining an absolute terrestrial position of the receiver from the absolute terrestrial position of at least one of the detected transmitters. GPS is a method of determining absolute terrestrial position although, if GPS is used only to determine a two-dimensional position, it does not qualify as absolute terrestrial position. (Lupton 482 Figure 1, also Lupton 482, col 2, lines 16-30-and lines 42-53, also Hovorka 287 text and figures also Steven B. Leeb, Elmer C. Lupton , Deron Jackson, George Hovorka and Billie L. Bentzen, "Optical Communication", U.S. Provisional Patent Application 60/353,253, Filed February 1, 2002 (Leeb 253) which is included in its entirety by reference in and to which priority is claimed by Lupton 482 and which is included in its entirety by reference in this application.) An individual of ordinary skill in the art would know to determine absolute terrestrial position. See, for example, Brown 97 as illustrative of the art.

In another aspect, the invention is a method of determining location at a structure comprising providing a lighting infrastructure at a structure, the infrastructure having transmitters connected to lights optically transmitting GPS and a respective absolute terrestrial position of that transmitter through emitted light; detecting the respective absolute terrestrial position of at least one of the transmitters with an optical receiver; and determining a relative position of the receiver from the detected absolute terrestrial position by determining at least a two-dimensional position of the receiver relative to at least one of the detected transmitters. (Lupton 482 Figure 1, also Lupton 482, col 2, lines 16-30 and lines 42-53, also George B. Hovorka, Steven B. Leeb, Elmer C. Lupton 482 and Deron Jackson, "Visible Lighting Communication System", U.S. Provisional Patent Application 60/108,287, Filed November 13, 1998 (Hovorka 287) to which priority is

claimed by Hovorka 633 and Lupton 482 and which is included herein in its entirety by reference.)

The invention is also a method of determining a location at a structure comprising providing a lighting infrastructure having lights each optically transmitting a respective unique address through emitted light at a structure defining areas having at least one of the lights; detecting at least one of the lights with an optical receiver connected to a list structure associating each address with GPS and an absolute terrestrial position of a respective one of the lights; receiving the respective address of at least one of the detected lights with the receiver and determining an identity of at least one of the detected lights from the list structure; performing a list structure lookup with a process of the receiver to determine an absolute terrestrial position of at least one of the detected lights; determining at least a two-dimensional position of the receiver relative to at least one of the detected lights; and determining an absolute terrestrial position of the receiver from the absolute terrestrial position of at least one of the detected lights. (Lupton 482 Figure 1, also Lupton 482, col 2, lines 16-30 and lines 42-53, also Hovorka 287 text and figures.)

In another aspect the invention is a method of determining a location at a structure comprising providing a lighting infrastructure having transmitters each optically transmitting a respective absolute terrestrial position of that transmitter; detecting the GPS coordinates and the respective absolute terrestrial position of at least one of the transmitters with an optical receiver; and determining an absolute terrestrial position of the receiver from the detected absolute terrestrial position. (Lupton 482 Figure 1, also Lupton 482, col 2, lines 16-30 and lines 42-53, also Hovorka 287 text and figures.)

The invention, in another aspect, is an optically-based location system, comprising a lighting infrastructure having optical transmitters each configured to illuminate and to transmit a respective relative position of said transmitters with respect to a fixed position; and an optical receiver configured to detect at least one of said transmitters and to determine from the detection a relative position of said receiver ((Lupton 482, Abstract). Also Lupton 482, Fig 1 and Lupton 482, col 4, line 35 through

col 3, line 4. Also Steven B. Leeb, George B. Hovorka, Deron K. Jackson and Elmer C. Lupton, "Dual-Use Electronic Transceiver Set for Wireless Data Networks) U.S. Patent 6,198,230, issued March 6, 2001 (Leeb 230) to which priority is claimed by and which is incorporated in its entirety by reference in Steven B. Leeb "Dual-Use Electronic Transceiver Set for Wireless Data Networks" U.S. Patent 6,426,599, issued July 30, 2002 (Leeb 599) to which priority is claimed by and which is included in its entirety by reference in Leeb 378 to which priority is claimed by and which is included in its entirety by reference in this application col. 11, line 26 –col. 12 line 5. The PCT application corresponding to Leeb 230 is WO99/53732-published October 21, 1999 which is incorporated herein in its entirety by reference. This lighting infrastructure can be inside a building (Leeb 230 Col 11, lines 47-48 also Lupton 482 col. 1, lines 14-16.) The transmitters can be lights (Lupton 482, col. 2, lines-11-50.) The lights can be fluorescent lights, each with a ballast and each of the transmitters part of a ballast of the fluorescent lights. (Leeb 230 col. 3 lines 20 - 35). The lights can be configured to transmit respective relative position through emitted lights. (Lupton 482, Abstract. Also Lupton 482, Fig 1 and Lupton 482, col. 4, line 35 through col. 3, line 4 also col. 6 line 5 -63.) The transmitters can be configured to transmit relative position through modulation of emitted light and the receivers can be configured to demodulate and identify respective relative position from the emitted light. (Lupton 482, Abstract. Also Lupton 482, Fig 1 and Lupton 482, col 4, line 35 through col 3, line 4 also col 6 line 5 - 63.) The system can have transmitters being fluorescent lights controlled by unique ballasts effecting periodic transmission of respective relative-position through emitted fluorescent light. (Lupton 482, Abstract. Also Lupton 482, Fig 1 and Lupton 482, col 4, line 35 through col 3, line 4 also col 6 line 5 - 63 also Leeb 230 col 11 line 26 - col 12 line 5.) The system can have these unique ballasts configured to control power supplied to the fluorescent lights for varying illumination into a form recognized by the receiver as respective relative position. (Lupton 482, Abstract. Also Lupton 482, Fig 1 and Lupton 482, col 4, line 35 through col 3, line 4 also col 6 line 5 --63 also Leeb 230 col 11 line 26 - col 12 line 5.) The system can be configured to modulate illumination from fluorescent lights to

vary illumination into a form recognized by the receiver as respective relative position (Lupton 482, Abstract. Also Lupton 482, Fig 1 and Lupton 482, col 4, line 35 through col 3, line 4 also col 6 line 5 - 63 also Leeb-230 col 11 line 26 - col 12 line 5.) The system can have transmitters with a transmit signal strength and receivers with an optical power detector for detecting a received signal strength and for comparing received signal strength to transmit signal strength to form a distance measurement. (Hovorka 633, col 3 lines 28-37 also col 7, line 56 - col 8 line 45.) The receiver can be portable (Hovorka 633 col 9 lines 52-54 also Lupton 482 col 4 lines 41-46.) We disclose that the receiver can be located in a device or devices including a computer (Lupton 482 Fig 1 and col 1 lines 44-48 also Hovorka 287 text and figures), telephones (Hovorka 287 text), visitor badges (Hovorka 287 text), light weight-receivers (Hovorka 287 text), a personal audio receiver (Hovorka 287 text and figures), an ear insert (Hovorka 287 text), a security badge (Hovorka 287 text), a headphone set (Hovorka 287 text and figures), an automated guidance system (Hovorka 287 text and figures), a "smart" wheel chair (Hovorka 287 text and figures), a handheld computer (Hovorka 287 figures and text), personal data assistant (Hovorka 287 figures), a personal information device (Hovorka 287 text and figures), a small information receiver (Hovorka 287 text), laptop computers (Hovorka 287 figures), a CD player (Hovorka 287 text), a wrist band (Hovorka 287 text), a badge (Hovorka 287 text), a personal locator and minder (Hovorka 287 text), a small personal receiver (Hovorka 287 text), Personal Biomedical Monitor (Hovorka 287 text), a receiver to present audio information (Hovorka 287 text), a receiver to present textual information (Hovorka 287 text), a receiver to control instrumentation electronics (Hovorka 287 text), a receiver to present mapping information (Hovorka 287 text). A badge is a type of jewelry and an individual of ordinary skill in the art will know to use other types of jewelry as a design for light weight, small personal receivers (also Avestruz 486, text.) The receiver can have a display for showing relative position of the receiver (Hovorka 287, figures and text also Lupton 482 Fig 1 and col 6, lines 5-21).

The system of the invention can have silicon detectors (Hovorka 287, figures and text also Hovorka 633 col 7, lines 32-33) and other commercially available composite

preamplifier/photodetector modules and photo detectors (Hovorka 287 text). With these teachings, an individual of ordinary skill in the art would know to use gallium arsenide photo detectors charge couple device detectors and charge couple arrays (see, for example, The Infrared Handbook, William L. Wolfe and George J. Zissis, eds. Infrared Information and Analysis Center, Environmental Research Institute of Michigan for ONR, Dept. of Defense, 1978; Physics of Semiconductor Devices, S.M. Sze, 2nd ed. Wiley-Interscience, NY, 1981 and P. Horowitz and W. Hill, The Art of Electronics, Cambridge University Press, 1989, all of which are included herein in their entirety by reference and Azuma 95, Lutz 94, Pushkorius 88, Wilkins 92 as illustrative of the art).

The system of the invention can include a central station coupled to the optical receiver with the central station configured to determine a relative position of the optical receiver from at least one of the transmitters detected by the optical receiver (Lupton 482 Figure 1, Lupton col 6, lines 55-63 also Avestruz 486, text) An individual of ordinary skill in the art would consider and would know how to couple the optical receiver with the central station to determine the relative position of the optical receiver. See, for example, Brown 97, Schilit, Theimer 94, Nelson 95, Bacon 97, and Maass 98 as illustrative of the art. The system can include a central station coupled to the optical receiver through an RF link, an optical link, the lighting infrastructure (Lupton 482, col 7, lines 25-36), a local area network (Avestruz 486 text and figures) and a spacecraft (Hovorka 287 text). A spacecraft is a type of satellite. A person of ordinary skill in the art will know to couple the central station to the optical receiver using other communication methods to link to the central station including a modem, an acoustic link, an Internet connection, a direct cellular link. See also references listed elsewhere in this application on the art.

In another aspect, the invention is an optically-based location system comprising a lighting infrastructure having optical transmitters each configured to illuminate and to transmit a respective address; a list structure having a table associating each address of the transmitters with a relative position of each respective one of the transmitters with respect to a fixed position; and an optical receiver configured to detect at least one of the

transmitters and to determine from a detection a relative position of a receiver. (Lupton 482 figure 1, also col 6, line 6 – col 7 line 36.) The system can have a receiver with a detector and a processor connected to the list structure and to the detector with the processor configured to determine a relative position of the receiver by executing the steps of detecting at least one of the transmitters and a transmitted respective address of at least one of the transmitters with the receiver, determining a relative position of the receiver with respect to at least one of the transmitters detected, assessing the list structure with the processor using the addresses detected to obtain a relative position of at least one of the transmitters stored in the list structure and correcting the relative position of the receiver using the relative position of at least one of the transmitters to obtain a relative position of the receiver. (Lupton 482 figure 1, also col 6, line 6 - col 7 line 36 also Hovorka 287 text) The system can have the transmitters be fluorescent lights controlled by unique ballasts effecting a periodic transmission of the address through emitted fluorescent light and with the ballast controlling power supplied to the fluorescent light for varying illumination into a form recognized by the receiver as a unique address. (Lupton 482 figure 1 and text, also Leeb 230 and Hovorka 633) The list structure can be part of the receiver (Lupton 482 figure 1, also col 6, line 6 - col 7, line 36, also Hovorka 287 text and figures). The list structure can be external to the receiver and the receiver is coupled to the list structure through a transmission link (Lupton 482, figure 1, also col 6, line 6 - Col 7 line 35, also Hovorka 287 text and figures.) The system can include a central computer system hosting a transmission link which can be an RF link, an optical link, the lighting infrastructure (Lupton 482, col 7, lines 25-36) ,a local area network (Avestruz 486 text and figures) and a spacecraft (Hovorka 287 text). A spacecraft is a type of satellite. A person of ordinary skill in the art will know to couple the central station to the optical receiver using other communication methods to link to the central station including a modem, an acoustic link, an Internet connection, or a direct cellular link. (Lupton 482 Figure 1, Lupton col 6, line 6 - col 7, line 36 also Avestruz 486, text.) See also references elsewhere in this application on the art. The system can update the list structure to add information to that table regarding new transmitters added

to the infrastructure, modify information regarding existing transmitters moved to a new position in the infrastructure and delete information regarding transmitters removed from the infrastructure. (Lupton 482, col 6, line 6 – col 7, line 36.) An individual of ordinary skill in the art would know how to update the list structure, modify information on additional transmitters and delete information regarding transmitters. See, for example, Schilit Adams 94 as illustrative of the art.

The system can comprise a lighting infrastructure at a structure with light each configured to illuminate and to transmit a respective address through modulation of emitted light; a list structure with a table associating each address of the lights with a relative position of each respective one of the lights and an optical receiver configured to detect at least one of the lights, demodulate the respective address from the emitted light and determine from the detection a relative position of the receiver, with the receiver having a detector and processor connected to the list structure and to the detector with the processor configured to determine a relative position of the receiver by executing the steps of detecting at least one of the lights and a transmitted relative address of at least one of the lights with the receiver; determining a relative position of the receiver with respect to at least one of the detected lights, addressing the list with the processor using a detected, transmitted respective address to obtain a relative position of at least one of the lights stored in the list structure and correcting the relative position of the receiver using the relative position of at least one of the lights to obtain a relative position of the receiver. (Lupton 482, Fig 1, also col 6, line 6 - col 7 line 36.) The system can comprise a lighting infrastructure having optical transmitters each configured to illuminate and to transmit an absolute terrestrial position of the transmitters, an optical receiver configured to detect at least one of the transmitters and to determine from the detection an absolute terrestrial position of the receiver. (Lupton 482, Fig 1 also col 6, line 6 - col 7 line 36 also Hovorka 287 text and figures) An individual of ordinary skill in the art would know to determine absolute terrestrial position. See, for example, Brown 97 as illustrative of the art.

The system can comprise an optically-based location system comprising a lighting infrastructure having optical transmitters each configured to illuminate and to transmit a respective address, a list structure having a table associating each address of the transmitters with an absolute terrestrial position of each respective one of the transmitters and an optical receiver configured to detect at least one of the transmitters and to determine from a detection an absolute terrestrial position of the receiver (Lupton 482, Fig 1 also col 6, line 6 - col 7 line 36 also Hovorka 287 text and figures). The system can comprise an optically-based location system comprising a lighting infrastructure at a structure having lights each configured to illuminate and to transmit a respective address through modulation of emitted light, a list structure having a table associating the addresses of the lights with an absolute terrestrial position of the lights and an optical receiver configured to detect at least one of the lights, to demodulate the respective address from the emitted light and to determine from the detection an absolute terrestrial position of the receiver where the detector has a detector and a processor connected to the list structure and to the detector where the processor is configured to determine absolute terrestrial position of the receiver by executing the steps of: detecting at least one of the lights and a transmitted respective address of at least one of the lights with the receiver, determining a relative position of the receiver with respect to at least one of the lights detecting, assessing the list structure with the processor using a detected transmitter respective address to obtain an absolute terrestrial position of at least one of the lights stored in the list structure and correcting the relative position of the receiver using the absolute terrestrial position of at least one of the lights to obtain an absolute terrestrial position of the receiver. (Lupton 482, Fig 1 also col 6, line 6 - col 7 line 36 also Hovorka 287 text and figures) The system can comprise an optically based in-building location system, comprising a lighting infrastructure having optical transmitters each configured to illuminate and to transmit a respective address signal; and an optical receiver configured to decode the respective address of at least one of the transmitters, determine a distance and/or position relative to at least one transmitter from one or more measurements of the address signal, and transmit a position signal that includes the

predetermined distance or relative position. (Lupton 482 Fig 1 also col 1, lines 14-16 and col 6, line 6 - col 7 line 36 also Leeb 230 Col 11, lines 47-48.) This system can further comprise a central receiver control station that receives the position signal and determines the absolute terrestrial position and/or a position relative to another coordinate system. (Lupton 482 Fig 1 also col 1, lines 14-16 and col 6, line 6 - col 7 line 36 also Leeb 230 Col 11, lines 47-48, also Hovorka 287 text and figures.) An individual of ordinary skill in the art would consider and would know how to use a central receiver control station that receives the position signal and determine the absolute terrestrial position and/or position relative to another coordinate system. See, for example, Brown 97, Bacon 97

Other publications illustrative of the art are: A. Ward, A. Jones, and A. Hopper, “A New Location Technique for the Active Office”, IEEE Personal Communications October 1997, pages 42-47 (Ward 97), A. Ren and G.Q. Maguire Jr., “A Smart Network with Active Services for Wireless Context-Aware Multimedia Communications”, 1999 Emerging Technologies Symposium, Wireless Communications and Systems, April 12-13, 1999 (Ren 99) and G. Abowd “Software Design Issues for Ubiquitous Computing”, Proceedings, IEEE Computing Society Workshop on System Level Design VLSI '98.. Aptil 16-17, 1998.(Abowd, 1998)

The citations to our earlier patents and applications document some of our inventions taught here. However, they should not be regarded as exclusive and as the only documentation of our inventions in this application and in the documents to which priority is claimed and/or which are included herein by reference. We note U.S. Patent application 20020089722, Matthew R. Perkins et. al. Published July 11, 2002 which is included herein in its entirety by reference. (Perkins 722) To the extent that Perkins teaches inventions, we believe that the inventions taught here predate Perkins 722.

The art advanced substantially between the filing of Lupton 482, Leeb 230 and Hovorka 633 and the filing of Perkins 722. Publications illustrative of this advance in the art include: H. Tarumi, K. Morishita, M. Nakao, and Y. Kambayashi, “SpaceTag: an overlaid virtual system and its applications” IEEE International Conference on Multimedia Computing and Systems, Volume: 1 , June 7-11, 1999 Page(s): 207 -212

vol.1 (Tarumi 99); T.Pfeifer and R.Popescu-Zeletin, "A modular location-aware service and application platform ",Proceedings. IEEE International Symposium on Computers and Communications, 1999. , July 6-8 1999 Page(s): 137 –148 (Pfeifer 99); E. Kovacs, K. Rohrle, B. Schiemann, "Adaptive mobile access to context-aware services "Proceedings. First International Symposium on Agent Systems and Applications, 1999 and Third International Symposium on Mobile Agents., 3-6 Oct. 3-6 1999 Page(s): 190 – 201D (Kovacs 99) . Ko; Y. Sumi; Y. Choi; K. Mase "Personalized Virtual Exhibition Tour (PVET): an experiment for Internet collaboration", Conference Proceedings , 1999 IEEE International Conference on Systems, Man, and CyberneticsIEEE SMC '99. , Volume: 6 , 12-15 Oct. 12-15 1999 Page(s): 25 –29 (Ko 99), A. Leonhardi, U.Kubach, K. Rothermel, and A. Fritz, "Virtual information towers-a metaphor for intuitive, location-aware information access in a mobile environment", Digest of Papers. The Third International Symposium on Wearable Computers, 1999. , Oct. 18-19 1999 Page(s): 15 – 20 (Leonhardi 99); B. J. Rhodes, N. Minar, and J. Weaver, "Wearable computing meets ubiquitous computing: reaping the best of both worlds" Digest of Papers. The Third International Symposium on Wearable Computers, 1999. , Oct. 18-19 1999 Page(s): 141 –149 (Rhodes 99); P. Couderc, A-M Kermarrec, "Improving level of service for mobile users using context-awareness ",Proceedings of the 18th IEEE Symposium on Reliable Distributed Systems, 19-22 Oct. 19-22 1999 Page(s): 24 –33 (Couderc 99); A.K.Dey, D. Salber, G.D. Abowd, M. Futakawa, "The Conference Assistant: combining context-awareness with wearable computing "Digest of Papers. The Third International Symposium on Wearable Computers, 1999. , Oct. 18-19 1999, Page(s): 21 –28 (Dey 99) ; P. Bahl, and V. N. Padmanabhan, "RADAR: an in-building RF-based user location and tracking system ",Proceedings INFOCOM 2000. Nineteenth Annual Joint Conference of the IEEE Computer and Communications Societies.. Volume: 2 , 26-30 March 26-30 2000 Page(s): 775 -784 vol.2 (Bahl 00); A. Jagannathan, H. Sung-Woo, J. Lillis, "A fast algorithm for context-aware buffer insertion ",Proceedings 37th Design Automation Conference, 2000. June 5-9, 2000 Page(s): 368 –373 (Jagannathan 00); U. Kubach, K. Rothermel "An adaptive, location-aware hoarding mechanism ",Proceedings. ISCC

2000. Fifth IEEE Symposium on Computers and Communications, 2000. July3-6 2000, Page(s): 615 –620 (Kubach 00); D. Kim; C. Toh and Y. Choi " Location-aware long-life route selection in wireless ad hoc networks " Electronics Letters , Volume: 36 Issue: 18 , Aug. 31 2000 Page(s): 1584 –1586D. (Kim Toh 00) ; D. Kim, Y. Choi, C.K. Toh, "Location-aware long-lived route selection in wireless ad hoc network ", 52nd Vehicular Technology Conference, 2000. IEEE VTS-Fall VTC 2000. , Volume: 4 , Sept. 24-28 2000 (Kim Choi 00): Y. Chen, K. Lai "MESH: multi-eye spiral-hopping routing protocol in a wireless ad hoc network ",Proceedings. Ninth International Conference on Computer Communications and Networks, 2000. , 16-18 Oct. 16-18 2000 Page(s): 657 – 661 (Chen 00); Mandato, E. Kovacs, F. Hohl, H. Amir-Alikhani, "CAMP: a context-aware mobile portal " Service Portability and Virtual Customer Environments", 2000 IEEE , Dec. 1, 2000, Page(s): 52 –61 (Mandato 00); T. Kindberg, J. Barton, J.Morgan, G. Becker, D. Caswell, P. Debaty, G. Gopal, M. Frid, V. Krishnan, H. Morris, J. Schettino, B. Serra,M. Spasojevic; "People, places, things: Web presence for the real world ",Third IEEE Workshop on Mobile Computing Systems and Applications, Dec. 7-8 2000, Page(s): 19 –28, all of which are incorporated in this application in their entirety by reference.

Brief Description of the Drawing

Fig. 1 is a schematic illustration of the invention.

Fig. 2 is a schematic illustration of a guidance embodiment of the invention.

Fig. 3 is a schematic representing the relationship among various elements that may comprise the communication network of the present invention.

Fig. 4 is a schematic illustrating another embodiment of the communication network of the present invention.

Fig. 5 is a schematic illustrating how the communication network of the present invention may be used in connection with a vehicle.

Fig. 6 is a schematic representing the relationship among various elements that may comprise the communications network of the present invention.

Detailed Description of Certain Preferred Embodiments

A Computer as a User

One important application for our communication network involves inputting data into a computer. In one usage of this approach, light can be used as a positional locator or a data source. One such device which would use light provided digital data we will refer to as a Personal Locator and Minder or PLAM. In this system, each modulated light will deliver a relatively simple unique signal. This signal could either be a random signal which is uniquely assigned to that light, or else could be based on some kind of geographical matrix. The Personal Locator and Minder will receive the signal from the nearest modulated light, identify the location of that light from information in its memory, compare the location of that light with the location the PLAM is scheduled to be at that particular moment, and then carry out appropriate actions in accordance with its preprogramming. This aspect has application to patients in a hospital or assisted care facility context.

Since each patient has their own PLAM programmed with their own schedule, the system can accommodate as many different patients simultaneously as is desired. Each light will be continuously communicating location. The individual patient's PLAM will be reading this location information and then giving the individualized guidance to the patient.

The second programming feature which can be included in the PLAM will be the ability to record the daily activities and mobility of a patient. In addition to providing and cueing a personal schedule for a patient, the PLAM can also record how many warnings or inconsistencies in schedule versus actual location occurred during the course of an arbitrary time interval. This information could be stored in the PLAM and downloaded when convenient giving a unique and highly detailed record of a patient's mobility and awareness at every location and time during a day.

Another important application for the computer as user will involve the use of an addressable electronic memory device. This device can be a RAM type device, ROM computer memory or storage device like a CD. The addresses can be partially or totally selected based on information provided over modulated lights. The information from the memory can then be used for any of the purposes well known in the art.

Still another application for the computer as user involves the decryption of an encrypted message. The message is encrypted using a method known in the prior art for which there is a decryption key. The key is not provided to the user and is not retained in the computer. The decryption key is supplied continually over the modulated lights. Only when the lights are providing the key can the user decode the information. The security code can be varied in a timed fashion or some other method known in the art. This providing of the decryption code by the lights will provide an additional level of security since only when the user is in the physical presence of the lights will the encrypted message be able to be decoded.

The most general statement of our invention is that it involves simultaneous intentional dual use of transmitted electromagnetic radiation for two or more functionally different useful purposes. An example of such a dual use of electromagnetic radiation other than visible radiation would involve the frequency modulation of a radar signal used to track civilian aircraft so that it also would carry audio information to the aircrew. Another such example would involve the modulation of an infrared illuminator used to allow night vision goggles to be used so that the operator of the illuminator could communicate with the wearer of the night vision goggles or with another user in the field of vision of the infrared illuminator. One preferred embodiment of this invention in electromagnetic wavelength ranges outside the visible is in the infrared wavelength range, another preferred embodiment is in the ultraviolet wavelength range, another preferred embodiment is in the X-ray wavelength range, another is in the radio wavelength range, another is in the microwave wavelength range.

When the wavelength range of the electromagnetic radiation used for one or more simultaneous functionally different useful purposes is outside the visible wavelength

range, we will refer to that radiation as "non-visible radiation." It is understood that under some circumstances, a source which is intended to generate electromagnetic radiation outside the visible wavelength range will also generate some visible radiation. If one or more of the simultaneous useful purposes makes principal use of radiation outside the visible wavelength range, it will be considered "non-visible radiation" notwithstanding the generation of the visible radiation. An example would be a sun tanning booth in which the UV light source would be modulated in order to allow communication with the user. Even though the UV light source would simultaneously generate some visible electromagnetic radiation, the useful purpose of tanning the skin would make principal functional use of ultraviolet radiation, so this radiation would qualify as "non-visible radiation." This designation as "non-visible radiation" would pertain whether the modulated UV light is detected by the receiver and used for communication, or the simultaneously generated visible electromagnetic radiation is detected by the receiver and used for communication. Since one useful purpose , namely tanning the skin, makes principal use of electromagnetic radiation outside the visible wavelength range, the radiation qualifies as "non-visible radiation."

In one preferred embodiment of this invention, one useful functional purpose of the embodiment is communication and the other useful functional purpose is some purpose other than communication. In another preferred embodiment, both useful functional purposes of the embodiment are some purpose other than communication.

In one preferred embodiment of the invention, one of the useful functional purposes makes primary use of electromagnetic radiation outside of the visible wavelength range. In another preferred embodiment of the invention, two or more of the useful functional purposes make primary use of electromagnetic radiation outside of the visible wavelength range.

An essential part of this invention is that the electromagnetic radiation must be free from application unacceptable flicker. Generally, this application unacceptable flicker occurs when variations due to the second utility of the radiation interfere with the first utility or vice versa. An example of application unacceptable flicker for visible radiation

would be visually perceptible flicker such that the light is considered unacceptable for illumination. For other examples, such as a radar set, application unacceptable flicker could mean that the flicker would interfere with radar detection.

In the examples below, the exact circuitry and systems can be designed and built by an individual of ordinary skill in the art of electrical engineering using, where appropriate, the unique communication network of our previously filed patent applications identified above.

Example 1 - Personal Locator and Minder Network

As is shown in Fig. 1, the network is created with a plurality of modulated lights 30, each transmitting its own unique signal. In a preferred embodiment, each modulated light 30 is self contained, except optionally for a power supply, which can be either line power or battery power. The modulated lights are not controlled from a central location.

The PLAM in this example contains a photocell 32 capable of receiving light and circuitry capable of demodulating the signal from the nearest light and identifying the unique signal, a clock 34, a computer memory 36 capable of storing the desired location of the PLAM at any specified time, and a computer 38 capable of evaluating signal received from the photocell 32, comparing that signal with the desired location of the PLAM and presenting information to the user based on the comparison. This information could be reassurance or silence if the signal received is the desired preprogrammed location signal, while it could be guidance or remonstrance if the signal received is not the desired preprogrammed location signal.

Each of a plurality of users can have their own PLAM programmed with their own schedule. Each light will be continuously communicating location. The individual user's PLAM will be reading this location information and then giving the individualized guidance to the user.

PLAM and its enhancements can be valuable to a number of users including brain disabled individuals, such as individuals suffering from traumatic brain injury, Alzheimer's disease or other dementia; children in a child care environment; and individuals in a secure environment whose movements must be monitored and recorded.

Example 2 - Enhanced Personal Locator and Minder

PLAM is programmed with the planned schedule for the user. When the time for one of the day's scheduled activities is noted by PLAM, the device takes note of the nearest modulated light and compares that with the location where the patient should be. If the light is in the place where the user is scheduled to be, the device simply notes this. However, if the user is in a place other than where he or she is scheduled to be, the device will remind the user of their scheduled location. A more sophisticated version of PLAM will also have in its memory the proper route for the patient to take to proceed to their desired location. As the user would proceed along the path to their desired location, PLAM will take note of the lights which the device is passing and correct the patient if they should take a wrong turn or stop.

Example 3 - Personal Locator and Minder with Alarm

The PLAM also contains a radio transmitter, microwave transmitter or other transmitter device. If the user of the PLAM is determined by the computer to be in an unauthorized area, this PLAM sends a signal to an attendant. This attendant could be a nurse in a hospital environment, a teacher or day care attendant in a day care environment or a security guard in a secure environment.

Example 4 - Personalized voice messages

In the previous examples, the computer memory of the PLAM is programmed with a voice of personal significance to the user. We define a voice of personal significance to the user to be a voice of a person who has some significant emotional and/or historical tie to the user. Most preferred as voices of personal significance would be the voice of the person themself, or the voices of the person's parents, siblings, children, spouse, business partners. or close friends. Other examples of voices of personal significance, not intending to be limiting, would be the person's former spouse(s), school classmates, friends and acquaintances, coworkers, current or former neighbors, and physicians, nurses or other caregivers.

Example 5 - Enhanced PLAM with recording capability

To the PLAM of Example 2 will be the ability to record the daily activities and mobility of a user. In addition to providing and cueing a personal schedule for a user, the PLAM can also record how many warnings or inconsistencies in schedule versus actual location occurred during the course of an arbitrary time interval. This information could be stored in the PLAM and downloaded when convenient by a monitor, such as a skilled care provider, giving a unique and highly detailed record of a user's mobility and awareness at every location and time during a day.

Example 6 - Programming the PLAM using modulated lighting

To the PLAM of Example 2 will be add the ability to have the programming in the computer changed by information received over the lighting. The programming information is transmitted over light using one of the techniques previously taught. The information is prefaced with a code to indicate to the computer that it is programming information. The programming information so received is then stored in the computer memory and used by the computer in making decisions and in giving guidance to the user.

Example 7 - Message selected from Computer Memory

A memory device such as a computer memory, CD, or tape is loaded with a number of messages which can prove useful. Each message is stored in a coded, identifiable location in the memory device. A coded signal is sent over the network indicating which coded location and which message should be played. The coded signal is received, processed by a computer and used to identify and call up the message from the memory. The message from the memory is presented to the user. This message could be an audio message, textual message, graphical message or other message.

Example 8 - Mixed Message from Computer Memory and Light Carried Message

The devices of Example 7 have an enhanced capability to receive and process more extensive information from the lights. The system has the capability to present information in a mixed fashion. As an example, the system could be cued to present and then present aurally" This is the office of" from the computer memory and then "Mr. Smith" from the light transmitted audio message.

Example 9 - Encryption Code

A message is encrypted using one of a number of encryption techniques known in the art which require an decryption code. The user is not provided with the decryption code. The computer or other device provided to the user has a receptor circuit which can receive and process encoded signals from the lighting in the area. The ambient lighting is modulated to contain the decryption code. The computer is able to process and decrypt the encrypted message only so long as the receptor circuit is viewing and processing the decryption code.

Example 10 - Multiple Channels

A network is constructed with two or more lights in proximity transmitting information on two or more different frequencies or else with one or more lights each transmitting information on two or more different frequencies creating channels of information. A receiver is provided which is able to receive and process information from these channels. Different information is transmitted on the different channels.

Example 11 - Multiple Channels to transmit different languages

In the network of Example 10, information is transmitted using the different channels to transmit different languages. As an example, one channel could transmit information in English and another channel to transmit the same information in Spanish.

Example 12 - Lighting to provide descriptions of exhibits

In an facility where there are two or more areas with different items being exhibited, each area is provided with its own separate lighting. This lighting is modulated to provide a description of the exhibit which is being lighted. The user is provided with a receptor which will allow the user to receive a description of the exhibit. As the user moves from one exhibit to another, the lighting provides the appropriate description of the exhibit which they are viewing.

Example 13 - Assistance to the Visually Impaired

The lights in a facility are modulated to provide guidance information to individuals who are visually impaired. This information could be of the sort of "Office X is on the

right" or "The stairs are on the left." A visually impaired individual would have a receptor to process this information and receive the guidance.

Example 14 - Assistance to the Hearing Impaired - Aural

The lights in a facility are modulated to provide information to individuals who are hard of hearing and require assistance. The information could be provided through a speaker, earphones or through a neck loop into a magnetic induction type hearing aid.

Example 15 - Assistance to the Hearing Impaired - Textual

The lights in a facility are modulated to provide information to individuals who are deaf or hard of hearing and require assistance. The information could be textual, graphical or pictorial information.

Example 16 - User which is Moving

The lights in an area are modulated to contain information. A user which is moving is provided with a receiver. Information is transmitted to the user which is moving.

Example 17 - Lighting Inside a Vehicle

The lighting inside or on a vehicle is modulated to contain information. A user inside or on the vehicle is provided with a receiver. Information is transmitted to the user which is inside or on the vehicle. The vehicle can be an aircraft, boat, submarine, bus, auto, tank, other military vehicle, wheelchair, spacecraft or other vehicle. The vehicle can be moving or stationary.

Example 18 - Guidance and directional information to a vehicle

Lighting outside a vehicle is modulated to provide information. Each light or sequence of lights is modulated to contain directional information or guidance information. The vehicle has sensors which in a sequential form will view the lights. By processing the information from the lights in sequence, and determining which lights are and are not in the field of view of the sensors, the vehicle can maintain its direction of travel. This is shown in the Fig. 2 below.

Example 19 - Modulated running lights

Circuitry is provided to modulate the running lights on a vehicle. These lights will carry information generated by a source inside the vehicle. A receiver outside the vehicle

can receive and process this modulated light and process the information to a user outside the vehicle. Another embodiment of this example would be the modulation of the headlights on a vehicle.

Example 19 - Repeater Network

One light in a facility is modulated with a signal to carry information. An adjoining light has a receptor which is positioned to view the signal from the first light. This signal is processed by the circuitry in the second light and the signal from the second light is modulated to transmit the same signal as is contained in the modulated signal from the first light. A third light has a receptor which is positioned to view the signal from the second light. This light also has a repeater circuit similar to the second light. A network of lights throughout the facility is, in this manner, modulated to carry the same signal as the first light.

Example 20 - Transmission through fluid

A light is modulated to carry a signal. The electromagnetic radiation from this light is allowed to fall on a receiver/receptor and the signal is processed. Water is placed in the path between the light and the receiver. No change is observed in the signal which is processed. The light is carried by a SCUBA diver who is underwater and is using the light for underwater illumination. The receiver is carried by another SCUBA diver who makes use of the information transmitted by the modulated light.

Example 21 - Transmission through vacuum or a reduced pressure medium

A light is modulated to carry a signal. The electromagnetic radiation from this light is allowed to fall on a receiver/receptor and the signal is processed. Air or any other gas is partially or completely removed from the medium between the light and the receiver to a pressure below 0.5 atmospheres. No change is observed in the signal which is processed. The light is carried by an astronaut who is in space and is using the light for illumination. The receiver is carried by another astronaut or by a spacecraft which makes use of the information transmitted by the modulated light.

Example 22 - Signal Source from Computer Memory provides repetitive signal

A computer memory is programmed to repeat, continuously, an information signal. This information signal is used to control the modulation of a light signal. A receiver receives and processes this information.

Example 23 - Signal Source provides non repetitive signal

A non repetitive signal is provided from a microphone, tape, CD, record or other information storage device. This non-repetitive signal is used to control the modulation of a light signal. A receiver receives and processes this information.

Example 24 - Lecture Hall

A network is created in a facility where two or more users are present. The users each have individual receivers and make personal use of the information transmitted by the lights.

Example 25 - Non-visible radiation - Ultraviolet

A mercury vapor lamp capable of producing ultraviolet radiation which can tan the skin modulated to carry information. A receiver of the type taught in the co-pending application above is able to detect the fraction of the radiation in visible range, demodulate it and extract the transmitted signal. Alternately, a photo detector capable of detecting ultraviolet radiation is used and the modulated ultraviolet radiation is detected, demodulated and the transmitted signal extracted and presented to the user. The ultraviolet light is also used for tanning the skin of the user.

Example 26 - Non-visible radiation - Infrared

An infrared illuminator is used to provide illumination for a viewing device which can receive infrared radiation and present it to a user as a visible display. This infrared illuminator is modulated to carry an analog audio signal. A receptor of the type taught in the co-pending application above is provided to receive and process this analog audio signal.

Example 27 - Non-visible radiation - MRI

A user is placed in an MRI device. The device is operated in the normal fashion, using electromagnetic radiation of the proper wavelength to create magnetic resonance.

This electromagnetic radiation is also modulated to carry information to allow communication with the user.

Example 28 - Compressed Data

Data from the signal source is compressed using a compression technique known in the art. Compressed data is transmitted over the network. The data is decompressed after it is received and processed by the receiver. The decompressed data is presented to the user.

The present invention has been described with respect to particular illustrative embodiments. It is to be understood that the invention is not limited to the above-described embodiments and modifications thereto, and that various changes and modifications may be made by those of ordinary skill in the art without departing from the spirit and scope of the appended claims.

We claim: